

IN THE CLAIMS

Please cancel Claims 11-17 without prejudice or disclaimer of the subject matter therein.

Please add new Claims 18-19 as follows:

--18. (New) The interconnect structure according to Claim 1, wherein the etch stop layer comprises doped silicon oxide.

19. (New) A method of forming an interconnect structure, the method comprising providing a contact dielectric layer, an etch stop layer over the contact dielectric layer, and a trench dielectric layer over the etch stop layer;

etching a hole through the contact dielectric layer and the etch stop layer;

etching a trench in the trenching dielectric layer;

introducing an electrically conductive interconnect into the hole and the trench; and

producing the interconnect structure of Claim 1.--

SUPPORT FOR THE AMENDMENT

This Amendment amends the specification; cancels Claims 11-17; and adds new Claims 18-19. Support for the amendments is found in the specification and claims as originally filed. In particular, support for the amendment to the specification is found at least in original Claim 1. Support for new Claim 18 is found at least in original Claim 1. Support for new Claim 19 is found at least in original Claims 1 and 11-17. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1-10 and 18-19 will be pending in this application. Claim 1 is independent.

REQUEST FOR RECONSIDERATION

Applicant respectfully requests entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

Applicant thanks the Examiner for the courtesies extended to their representative during the January 30, 2002, telephone interview discussing the Office Action.

The Office Action asserts that "[t]he information disclosure statement filed 10/17/00 has not been considered because the applications serial No (09/593,967; 09/593,968; 09/654,078) are still pending." Office Action at page 2, section 2. However, the Information Disclosure Statement filed October 17, 2000, meets the requirements of 37 C.F.R. §1.98. Thus, the Information Disclosure Statement filed October 17, 2000, must be considered. See MPEP §609. Applicants respectfully request a retraction of the Office Action statement that "[t]he information disclosure statement filed 10/17/00 has not been considered", and an indication that the applications cited in the Information Disclosure Statement filed October 17, 2000, have been considered by the Examiner.

The Office Action objects to the title of the invention as not being descriptive and asserts that a new title is required that is clearly indicative of the invention to which the claims are directed. However, in view of the addition of new method Claim 19 to the pending product claims, Applicant respectfully submits that the title of the invention "Dual Damascene Structure and Method of Making" is clearly indicative of the invention to which the claims are directed. Thus, the objection to the title should be withdrawn. Applicant respectfully requests reconsideration and withdrawal of the objection.

Claims 1-5 and 9-10 are rejected under 35 U.S.C. §102(e) over U.S. Patent No. 6,313,020 ("Chittipeddi"). In addition, Claims 6-8 are rejected under 35 U.S.C. §103(a) over Chittipeddi in view of U.S. Patent No. 6,130,102 ("White"). Applicant respectfully traverses

these rejections because Chittipeddi fails to *disclose* the independent Claim 1 feature of contact dielectric, etch stop and trench dielectric layers all comprising silicon oxide; there is no reasonable expectation that Chittipeddi would lead the skilled artisan to successfully reach this feature of Claim 1; and any *prima facie* case of obviousness based on the cited prior art is rebutted by the significant reduction in total dielectric constant in dual damascene structures achieved according to the claimed invention by replacing conventional etch stop layers with the recited etch stop layer comprising silicon oxide.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. MPEP §2131. To establish a *prima facie* case of obviousness, there must be a reasonable expectation of success. MPEP §2143. Objective evidence or secondary considerations such as unexpected results are relevant to the issue of obviousness and must be considered in every case in which they are present. MPEP §2141, page 2100-114, column 1.

The present invention provides a dual damascene structure in which a conventional etch stop layer (e.g., of silicon nitride) is replaced with an etch stop layer of either doped or undoped silicon oxide. Specification at page 4, lines 8-10. An etch chemistry containing $C_2H_2F_4$ (an optionally CHF_3) provides sufficient etch selectivity of the silicon oxide. Specification at page 4, lines 13-14.

In contrast to the claimed invention, Chittipeddi discloses a dual damascene structure including a first insulating layer 105, an etch stop layer 110 formed above or in direct contact with the first insulating layer 105, and a second insulating layer 115 above or in direct contact with the etch stop layer 115. Chittipeddi at column 2, lines 61-62; column 3, lines 10-11; 22-23. The second layer 115 may be formed using the same materials and processes used to form the first insulating layer 105. Chittipeddi at column 3, lines 23-25. The first insulating

layer 105 is, for example, a dielectric such as a high-density deposited silicon oxide (e.g., SiO₂); alternatively, the first insulating layer may be a borophosphosilicate glass, a phosphosilicate glass, a glass formed from phosphorous and/or boron-doped tetraethyl orthosilicate, spin-on glass, xerogels, aerogels or other low dielectric constant films such as polymer, fluorinated oxide and hydrogen silsesquioxane. Chittipeddi at column 2, lines 60-67. The etch stop layer may be TiN where the second insulating is SiO₂. Chittipeddi at column 3, lines 18-19. Further, the etch stop layer may be Ta/TaN, Si₃N₄, a silicon-rich oxide, or a multi-layered SiO₂ dielectric. Chittipeddi at column 3, lines 20-21.

However, Chittipeddi fails to disclose the independent Claim 1 limitation "the etch stop layer comprises one member selected from a group consisting of an undoped silicon oxide and a doped silicon oxide; and each of the contact dielectric layer and the trench dielectric layer independently comprises the other member of the group". In other words, Chittipeddi fails to disclose the independent Claim 1 feature of contact dielectric, etch stop and a trench dielectric layers all comprising silicon oxide.

Because Chittipeddi fails to disclose each and every element of independent Claim 1, Chittipeddi fails to anticipate Claim 1.

Chittipeddi also fails to have rendered obvious Claim 1, because there is no reasonable expectation that Chittipeddi would successfully lead the skilled artisan to the interconnect structure of Claim 1 in which the contact dielectric, etch stop and trench dielectric layers all comprise silicon oxide. Chittipeddi is silent about an etch chemistry selective between doped and undoped silicon oxide. Thus, there is no reasonable expectation that Chittipeddi would lead the skilled artisan to successfully etch the contact dielectric, etch stop and trench dielectric layers of doped or undoped silicon oxide of Claim 1 to reach the interconnect structure of Claim 1.

White fails to remedy the deficiencies of Chittipeddi. White is cited for disclosing that is conventional in the art "to form a gate structure comprises a gate dielectric (18) over the substrate (12), a gate (20) over the gate dielectric, a cap dielectric layer over the gate, and the spacers (24) adjacent to the gate and the cap dielectric, wherein the gate structure on the substrate in contact with the contact dielectric layer (28)". Office Action at page 5, section 7, lines 7-11. However, White is silent about an etch chemistry selective between doped and undoped silicon oxide and fails to suggest the feature of independent Claim 1 of contact dielectric, etch stop and trench dielectric layers that all comprise silicon oxide. Thus, White fails to remedy the deficiencies of Chittipeddi.

Any *prima facie* case of obviousness based on Chittipeddi, or on Chittipeddi in view of White, is rebutted by the significant improvement in total dielectric constant achieved in dual damascene structures as recited in independent Claim 1. In conventional dual damascene structures, a silicon nitride etch stop layer is sandwiched between layers of silicon oxide. Specification at page 8, lines 13-14. The silicon nitride increases the effective dielectric constant of the dual damascene structures. Specification at page 8, lines 14-15. Replacing the silicon nitride with undoped silicon oxide eliminates a source of increased dielectric constant in dual damascene structures and can lead to a **10-40% reduction** in total dielectric constant relative to an otherwise identical dual damascene structure having a silicon nitride etch stop layer. Specification at page 8, lines 16-19. The cited prior art is silent about the reduction in total dielectric constant that is achieved according to the claimed invention when the contact dielectric, etch stop and trench dielectric layers all comprise silicon oxide. Thus, any *prima facie* case of obviousness based on the cited prior art is rebutted.

Because Chittipeddi fails to disclose all the limitations of independent Claim 1, there is no reasonable expectation of success, and any *prima facie* case of obviousness is rebutted,

the rejections over Chittipeddi, and over Chittipeddi in view of White, should be withdrawn.

Applicant respectfully requests reconsideration and withdrawal of the rejections.

New Claim 18 is further patentably distinguishable over the cited prior art, because the cited prior art fails to suggest an etch stop layer comprising *doped* silicon oxide.

Pursuant to MPEP §821.04, after independent product Claim 1 is allowed, Applicant respectfully requests examination and allowance of new method Claim 19, which includes all the limitations of product Claim 1.

In view of the foregoing amendments and remarks, Applicant respectfully submits that the application is in condition for allowance. Applicant respectfully requests favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned attorney at the telephone number listed below.

Respectfully submitted,

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Attachment:

Marked-up copy of amendments



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OFFICE OF PETITIONS



MARKED-UP COPY OF AMENDMENTS

IN RE APPLICATION OF:

JIANMIN QIAO

: GROUP ART UNIT: 2814

SERIAL NO: 09/654,078

FILED: SEPTEMBER 1, 2000

: EXAMINER: PHAM, H.

FOR: DUAL DAMASCENE STRUCTURE
AND METHOD OF MAKING

AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

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AUG 07 2002

OFFICE OF PETITIONS

SIR:

In response to the Office Action dated November 29, 2001, please amend the application identified above as follows (marked-up copy of amendments attached):

IN THE SPECIFICATION

Please amend the specification as follows:

Amend the paragraph at page 5, lines 2-8, as follows:

(Amended) A dual damascene interconnect structure according to the invention includes a contact dielectric layer, an etch stop layer of undoped ~~or doped~~ silicon oxide on the contact dielectric layer, a trench layer on the etch stop layer, and a continuous electrically conductive interconnect passing through holes in the contact dielectric layer, the etch stop layer and the trench layer. The term "undoped" as used herein refers to a dopant concentration of less than 1.0 wt.%. Conversely, the term "doped" as used herein refers to a dopant concentration of greater than or equal to 1.0 wt.%.

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